IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Serial No.	:	**10/790,055**
Filed	:	March 2, 2004
Applicant	:	Sexton, et al.
Title	:	**Electrical Wire and Method of Fabricating the Electrical Wire**
TC/AU	:	2831
Examiner	:	William H. Mayo III
Docket No.	:	77335-0098
Customer No.	:	29052

DECLARATION OF FRED LANE MARTIN PURSUANT TO 37 C.F.R. § 1.132

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

I, Fred Lane Martin, hereby declare that:

1. I am a resident of Knoxville, Tennessee and have been working as an electrical engineer for over 30 years. I received a Bachelor's of Science in Mathematics in 1970 from East Tennessee State University and a Bachelor's of Science in Electrical Engineering in 1971 from the University of Tennessee. I then received a Masters in Science in Electrical Engineering from the University of Tennessee in 1973.

2. I began working as a consultant for DeCorp Americas in 2002. As a consultant, I participated in the development of advanced safety devices capable of providing additional safety during the use of flat wire products. In 2003, I became the Director of Research and Development of DeCorp Americas. In this role, I participated in and managed a team of developers that developed a multitude of flat wire products. I am currently in the process of

authoring a technical text encompassing more than 300 pages describing the development of flat wire products and the technology encompassed by flat wiring. Following the acquisition of DeCorp Americas by the Southwire Company in 2005, I became the Director of Research and Development for the Flat Wire Technologies Division of the Southwire Company. In this role, I am continuing to develop several flat wire products.

3. I am a named inventor of U.S. Pat. App. No. 10/790,055, entitled "Electrical Wire and Method of Fabricating the Electrical Wire," hereinafter referred to as the Patent Application.

4. I am familiar with the development of the electrical flat wire which forms the basis of the Patent Application. I helped design and develop the electrical flat wire encompassed by the Patent Application, and I am also participating in the process of getting the electrical flat wire approved for use in residences and other structures. The challenging design and development process, as well as the later commercial success, of the electrical flat wire described in the Patent Application are briefly described below.

<u>The Development Process and Design Challenges</u>

5. The development of a commercially viable electrical flat wire required knowledge of physics and applied mathematics as well as a knowledge of practical manufacturing methods in the copper foil rolling and film extrusion/slitting/adhesion technologies. The testing of A.C. electrical flat wire has been complicated and extensive, requiring the use of sophisticated test equipment and data analysis techniques.

6. The design goal when development of an electrical flat wire began was to develop a thin and therefore, easily concealable, electrical flat wire capable of safely carrying high current levels (up to 15 amps for U.S. applications) at standard voltage levels (90-130 VAC for U.S. applications and 220-250 VAC for worldwide applications). The electrical flat wire was designed to supplement or replace existing in-wall wiring in homes.

7. With regard to concealability, it was a design goal that the total thickness of the electrical flat wire be no more than 0.050 inches. This would ensure that the electrical flat wire could be mounted to the surface of a wall, ceiling or floor and then be concealed, for example, by spackling, painting, or wallpapering over the wire.

8. During the development of an easily concealed thin flat wire, many design challenges were encountered. The first challenge encountered stemmed from the desire that the three basic conductors (hot, neutral, and ground) remain insulated from each other. The further the distance between conductors, the less the insulator breakdown voltage becomes a factor. An initial electrical flat wire design placed the several conductors in a generally parallel relationship in a single plane (or coplanar). In the case of coplanar conductors, the conductors can be comfortably separated, but when the electrical flat wire is folded, forming a 90 degree turn, the conductors pass over each other such that the two outer insulation layers are all that avoids a short. Penetration of the outer insulation of the hot conductor in coplanar electrical flat wire is a possible hazard. After careful study it was determined that a coplanar approach even with an advanced GFCI type monitoring circuit would not be safe enough.

9. The next approach in the development of a safe, thin electrical flat wire was to try a multi-planar or stacked form. It was determined that the best sequence was five conductive layers configured as Ground-Neutral-Hot-Neutral-Ground (G-N-H-N-G), which functioned to maximally isolate the hot conductor and to avoid capacitive current on the ground layers. Therefore, the adjacent layers to the hot conductors in the stacked arrangement were designed to be neutrals. The outer ground layers may be added to serve as shields to/from electrical hum and interference as well as for providing additional current paths, upon penetration, to ground. It was also determined that the hot layer may be narrower than the other four layers to avoid the hot layer being close to the edges of the electrical flat wire, which leads to a higher degree of safety, as discussed in detail below. The development of multi-planar, protective layered flat wire was the result of much research including mathematical methods of physics, process work, trail-and-error, and testing.

Safety and Regulatory Agencies

10. Safety is the prime directive behind all flat wire design and manufacturing. Safety goals include electrical shock/electrocution protection, absence of startle effect from sound or flash, and fire safety.

11. The National Electrical Code (NEC), published by the National Fire Prevention Association (NFPA), is the basis for local electrical codes throughout the United States. The

NEC is revised and reissued every three years. The NEC revision process involves safety professionals, industry representatives, electricians, and other interested parties. The NEC includes requirements for all types of electrical installations from industrial to home. In homes, the NEC governs the code inspection of essentially all of the 240 Volt and 120 Volt household wiring. The NEC serves as the top-level document in the U.S. electrical safety system. Its primary emphasis is on wiring methods and on types of wires and cables. At the enforcement level lies the code inspector. Specific products are acceptable for use and inspector approval if they are approved (Listed) by an electrical safety agency. The primary U.S. electrical safety agency is Underwriter's Laboratories (UL). UL develops detailed standards for specific products in accordance with the general requirements set forth in the NEC. UL tests and approves (Lists) products for conformance with the applicable UL standard. UL standards cover all types of wiring products and all types of electrical devices.

12. Flat wire represents a new concept for electrical wiring. Flat wire, though novel and unique over conventional wire, is currently being adapted to Article 382 of the NEC, entitled Non-metallic Extensions. Article 382 generally covers exposed wiring and allows for surface mounted wiring. Other than the ability of the electrical flat wire to be concealed, flat wire currently meets the provisions of Article 382. In January of this year (2006), the responsible code committee of NEC voted 10-3 in favor of allowing flat wire to be used in a concealed manner under a modified Article 382.

13. Flat wire is currently in the process of being approved by UL. Upon requesting UL approval, flat wire was designated as a "New and Unusual Investigation," which is a designation given by UL for new technologies that are not covered under existing UL specifications. As a result, a special test program was developed and is currently being performed on the electrical flat wire, at least some of the results of which are discussed in Paragraph 20 below. UL approval of flat wire will open the door for installation of AC flat wire in new and existing construction under the general guidelines of Article 382.

14. Safety is a primary consideration in the design of wire systems that can carry dangerous voltage levels and that have a distinct possibility of penetration of an electrified (hot) conductor. Penetration or compromise of flat wire by objects such as nails, screws, drill bits, knife blades, saw blades, staples, darts, bullets, toys, etc. must be considered. Fire protection and

electric shock safety are based on limiting voltage, and therefore maximizing current (Ohm's Law), while expediting the trip time of a primary safety device (circuit breaker or fuse in branch circuit main box). Secondary protection such as a fuse local to a branch circuit of a room with flat wire is provided as a second "layer" of protection in case of a fault in the main (circuit breaker) safety box.

15. Protective layered electrical flat wire was designed to produce a short between earth ground, neutral, hot, a second neutral, and a second earth ground in that sequence upon penetration. With as much as four times the conductance ultimately to earth ground, a voltage divider is formed favoring the ground voltage over the line or hot voltage. Repeated tests show voltages present at the site of the penetrations do not exceed 50 VAC for longer than the primary safety device's trip time, typically under 25 ms.

16. Penetration can occur through the broadside or flat surface of flat wire by sharp objects or through an edge by a knife blade or drywall saw for example. In any case the resulting short causes a high current to be produced at a low voltage for a short (trip) time. Startle (e.g., sound burst) effect and localized heating are minimized due to the nature of the protective layered flat wire. It was determined during the development of the electrical flat wire that it is desirable to minimize the space (also referred to as gap) between a hot conductor and a neutral conductor. Minimizing this gap helps to ensure that a penetrating object cannot reach the hot conductor without also contacting a neutral conductor. During testing, it was determined that a gap between a hot conductor and a neutral conductor should be about 0.030 inches or less, to ensure that a penetrating object cannot contact the hot conductor without also contacting a neutral conductor. It was also discovered that greater safety can be achieved if the hot conductor is narrower than the neutral and ground conductors. A narrower hot conductor increases the probability that a penetrating object will contact a neutral or ground conductor prior to contacting the hot conductor. Through extensive testing, a safe electrical flat wire was developed that minimizes the chance of electrical shock if penetrated by a foreign object.

Nail Penetration Dynamics

17. FIG. 1 below shows the dynamics of a nail or tack penetration of multi-planar electrical flat wire. Again, protective layered electrical flat wire has a distinct advantage over

conventional in-wall electrical wire because it ensures that the penetrating object first passes through ground (G1) and then neutral (N1) conductors prior to any contact with the hot innermost conductor.

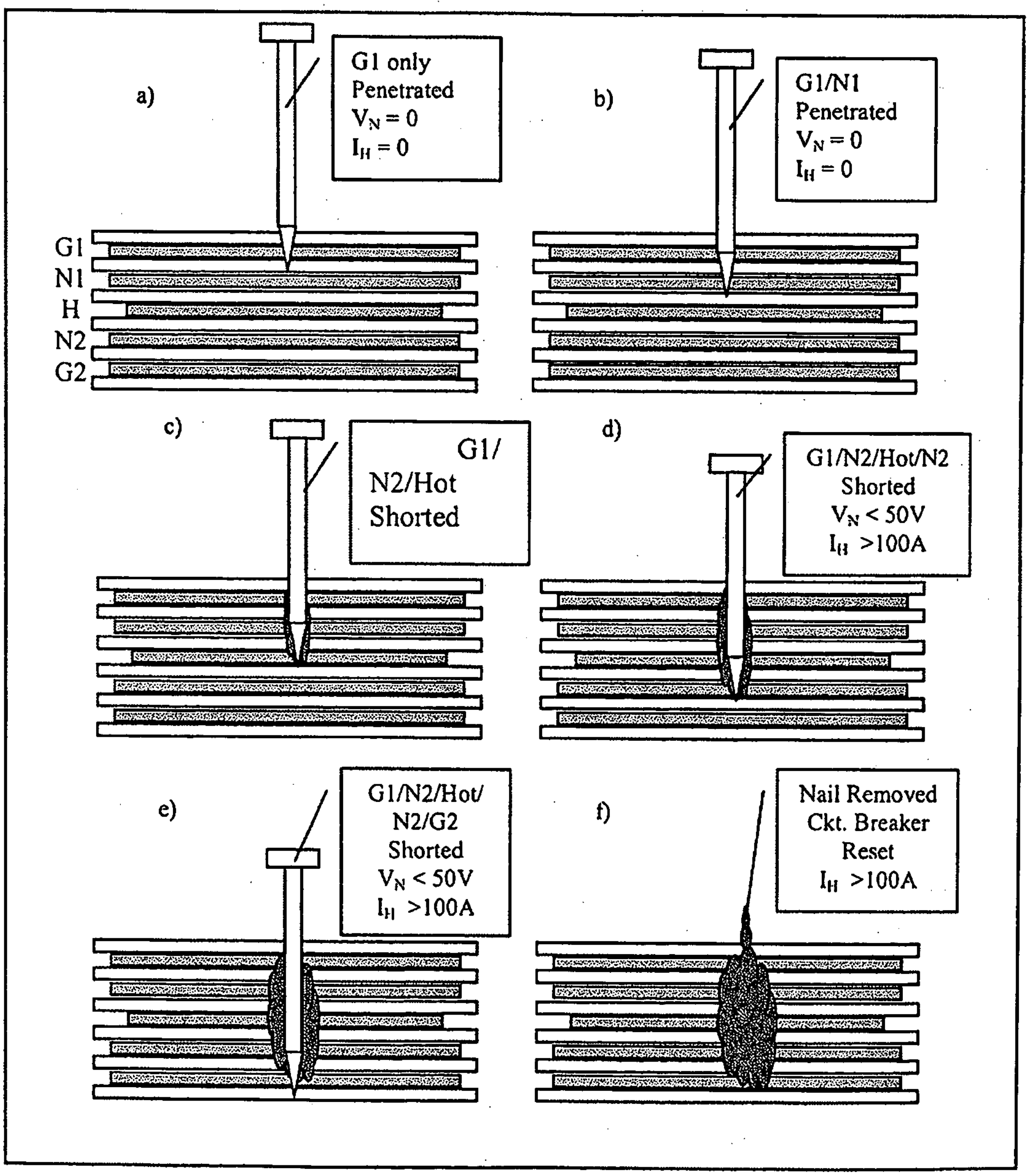

FIG. 1: **Multi-planar Flat Wire Penetration Dynamics**

18. In FIGS. 1a and 1b, there is voltage on the nail (V_N = 0 VAC) and the hot current is at some level of normal load current (I_H < 15 amps in U.S. and 6 amps in other parts of the world for a branch circuit). In FIGS. 1c through 1e, there is a relatively low voltage on the nail (V_N < 50 VAC for 120 VAC and 240 VAC line voltage) and the hot current exceeds 100 amps until the circuit breaker trips.

19. The time for penetrating from the outer layer to the hot conductor (FIGS. 1a – 1c) is typically under 1 ms, which is only a fraction of the trip time of a circuit breaker. Similarly, the time to continue penetration from the hot conductor to the backside outer layer (FIGS. 1c – 1e) is relatively short as well. The continuous nature of the short circuit during the penetration is due to two primary factors: (1) the conductor contact at the sides of the penetrating object is maintained by the insulation displacement process during penetration; and (2) the molten copper in the proximity of the contact area once the short begins. In FIG. 1f, the nail is shown removed and the circuit breaker is reset shortly before it trips again. During this reset/trip period some additional damage is done to the inner layers with a reasonable sound and visual report.

20. FIG. 2 shows the nail voltage waveform and hot conductor current waveform captured on a Gould Ultima 500 oscilloscope. Note that the trip time is less than 12 ms which is under one cycle of the 120 AC, 60Hz line voltage. The circuit breaker used was a 20 amp GE. The penetrating nail was a 4d common in size.

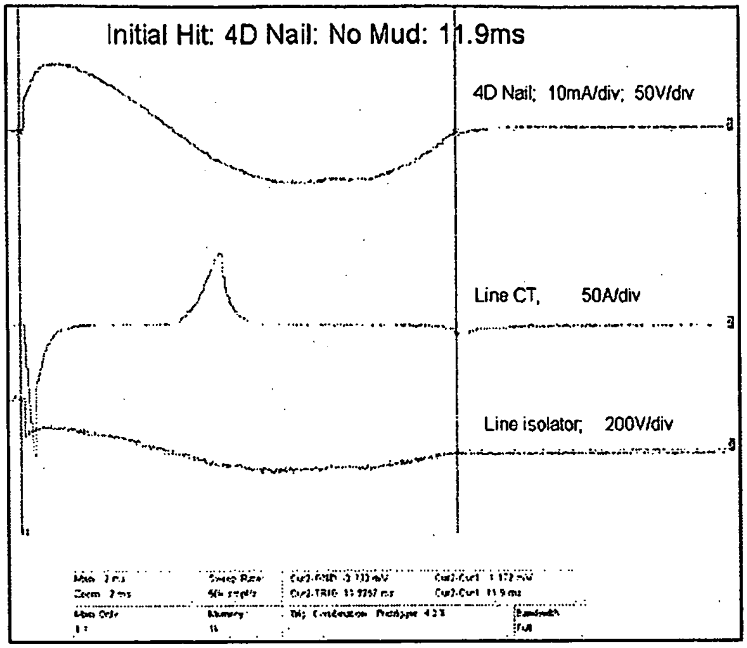

FIG. 2: Penetration Trip Time Waveform

21. During the process of having the electrical flat wire approved by UL, a multitude of tests were performed on the electrical flat wire to ensure that one or more circuit breaker would trip when various objects penetrated the electrical flat wire. Further, it was ensured that one or more circuit breakers would trip when the breakers were reset while the penetrating object was still in the wire and when the penetrating had been removed from the wire. The results of the tests performed before UL are attached to this Declaration as Appendix A.

Commercial Success

22. Regarding United States 120 VAC electrical wiring applications, the earliest forms of wiring homes (from the 1920s –1950s) utilized wire insulated with shellac permeated cloth wrap. Asphalted cloth wrap was used for insulation in the 1950s-1970s. Wire, as we know it today, with two insulated inner conductors (hot/neutral) and a non-insulated ground conductor, all within a thermoplastic outer insulator, has been used since the mid-1950s. Aluminum electrical wiring was installed in homes in the mid 1960s through the mid 1970s.

23. Many millions of homes today are facing end-of-life scenarios regarding their older wiring and run significant risk of fire damage and casualties. According to the National

Science and Technology Council November 2000 report, "Wire systems may become unreliable or fail altogether, due to poor design, use of defective materials, improper installation, or other causes. The risk of failure increases as wire systems age, due to cumulative effects of environmental stresses (e.g. heat, cold, moisture, or vibration), inadvertent damage during maintenance, and the wear and tear of constant use. The aging of a wire system can result in loss of critical function in equipment powered by the system... can jeopardize public health and safety and lead to catastrophic equipment failure or to smoke and fire.[1]" Furthermore, wire insulation and/or conductors can deteriorate due to radiation, high temperature, steam, chafing, mishandling, corrosion, mechanical loading, and vibration.

24. Reports issued by the Consumer Products Safety Commission (CPSC) show that in 1997 home wire systems caused over 40,000 fires that resulted in 250 deaths and over $670 million of property damage.[2] Further study by the CPSC based on 40,300 electrical circuit fires showed that 36% were due to installed wiring and 16% were due to cord/plugs.[3] Along with the usual wire system failures due to age and environmental stresses, aluminum wire systems were "prone to degradation and dangerous overheating.[4]" Thus, there clearly existed a need for a new type of A/C electrical wire that could be inexpensively installed in a home.

25. Since its development, electrical flat wire has been recognized as an innovative design which could revolutionize home wiring. In 2004, the electrical wire won the "Best of CES" award sponsored by TechTV in accessories category at the Consumer Electronics Show held in Las Vegas, Nevada. The CES TechTV awards show was aired several times on national television and featured the electrical flat wire. Also in 2005, the "I Want That" program on the HGTV channel ran several spots featuring flat wire. The flat wire technologies have received other awards and have had many articles written about the uniqueness of the technology.

26. Due to the commercial success, potential market opportunities, and long-felt need for an electrical wiring system that was surface-mounted, DeCorp Americas, the developer of the

[1] "Review of Federal Programs for Wire System Safety," Final Report, National Science and Technology Council, November 2000, p. 1, available at www.ostp.gov/html/wire_rpt.pdf.
[2] Id. at p. 10.
[3] Id. at p. 11.
[4] Id. at B8.

electrical flat wire, was acquired in 2005 by The Southwire Company. The Southwire Company is one of the largest producers of electrical wiring in North America, and they focus on manufacturing conductive wiring, including the Romex™ brand wire, which is generally considered the industry standard for electrical wire.

27. I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that willful false statements may jeopardize the validity of the application or any patent issued thereon.

Date: March 2, 2006

Fred Lane Martin

Fred Lane Martin

Appendix A: Tests Performed on the Electrical FlatWire During UL Testing

Test #	Test Description	# Breakers Tripped			Comments
		Original	Reset	Removed	
1	Energized 3 penny nail in flat at 90deg.	2	2	2	
2	De-Energized 3 penny nail in flat at 90deg.	2	2	1	
3	Energized 3 penny nail in flat at 45deg.	2	2	2	
4	De-Energized 3 penny nail in flat at 45deg.	2	2	2	
5	Energized 3 penny nail in fold at 90deg.	1	2	2	
6	De-Energized 3 penny nail in fold at 90deg.	2	2	2	
7	Energized 16 penny nail in flat at 90deg.	2	2	1	
8	De-Energized 16 penny nail in flat at 90deg.	2	2	2	
9	Energized 16 penny nail in flat at 45deg.	2	2	2	
10	De-Energized 16 penny nail in flat at 45deg.	2	2	2	
					End of first Flat wire sample
11	Energized DrywallScrew in flat at 45deg.	2	2	2	
12	De-Energized drywall screw in flat at 45deg.	2	2	2	
13	Energized DrywallScrew in flat at 45deg.	1	2	2	
14	De-Energized drywall screw in flat at 45deg.	1			reset and removed no curve as breaker did not trip and screw to ground voltage was measured and found to be 125 volts.
15	Repeat of 14	2	2	2	
16	Energized Utility flat 25%	2	2	N/A	
17	De-Energized utility flat 25%	1	2	N/A	
18	Energized plasticAnchor in flat at 90deg. screwed in spd 1	1	1	N/A	
19	De-Energized plasticAnchor in flat at 90deg. screwed in spd 1	2	2	2	
20	Energized utility blade 25% partial pen.	2	2	N/A	
21	Repeat less	2	2	N/A	
22	Energized sawblade cut till trip	1	2	1	
23	De-Energized sawblade cut till trip	1	2	N/A	
24	Direct short Test	2	N/A	N/A	
25	Energized dart 90deg.	1	2	2	
26	De-Energized dart 90deg.	1	2	2	
27	Energized dart 45deg.	2	2	2	
28	De-Energized dart 45deg.	2	2	2	
29	Energized 1/8" Drill Bit in flat 90deg.	2	2	2	
30	De-Energized 1/8" Drill Bit in fold 90deg.	2	2	N/A	

31	De-Energized 1/8" Drill Bit in flat 90deg.	1	2	N/A	
32	Energized 1/8" Drill Bit in fold 90deg.	1	2	N/A	
33	Energized on stud 8# Sledge Hammer 18" drop 90deg.in flat Test	NT	NT	NT	No Cable penetration
34	Energized on stud 8# Sledge Hammer 18" drop 45deg.in flat Test	NT	NT	NT	No Cable penetration
35	Energized Staple 90 Deg. In flat	2	2	2	
36	De-Energized Staple 90 Deg. In flat	1	2	2	
37	Energized 3 Penny nail flat partial penetration 90 deg. .125" deep	2	2	2	Nail still pentrated all 5 layers
38	De-Engergized 3 Penny nail flat partial penetration 90 deg. .100" deep	2	2	1	Nail still pentrated all 5 layers but did not pierce completely through
39	Energized 16 penny nail 90 deg. In fold	2	2	2	
40	Energized 16 penny nail 45 deg. In fold	2	2	2	
41	Energized Drywall screw 90 deg. In fold	1	2	2	
42	Energized Drywall screw 45 deg. In fold	1	2	2	
43	Energized Utility knife cut in fold	2	2	N/A	
44	Energized Plastic wall anchor 90 deg. in fold	1	1	N/A	Plastic anchors are extremely
45	De-Energized Plastic wall anchor 90 deg. in fold	2	2	N/A	difficult to get penetration.
46	Energized Dart 90 deg. In fold	2	2	2	
47	De-Energized Dart 90 deg. In fold	2	2	2	
48	Energized Keyhole saw in fold	1	2	N/A	
49	De-Energized Keyhole saw in fold	2	2	N/A	
50	Energized drywall screw 45deg. In fold	2	2	2	
51	De-Energized 3 penny nail 45 deg. In fold	2	2	2	
52	Energized Staple 90 Deg. In fold	2	2	2	
53	De-Energized Staple 90 Deg. In fold	2	2	2	
54	De-Energized 16 penny nail 90 Deg. In fold	2	2	1	
55	De-Energized 16 penny nail 45 Deg. In flat	2	2	2	
56	De-Energized 16 penny nail 45 Deg. In flat Retest	2	2	1	
57	De-Energized Utilitiy Knife In fold	2	2	N/A	
58	De-Energized Drywall Screw 90deg. In fold	2	2	2	
59	Energized 3 Penny nail 45deg. In fold	2	2	2	
60	Energized 1/8" Drill bit 45deg. In fold	2	2	N/A	
61	De-Energized 1/8" Drill bit 45deg. In fold	1	2	N/A	